Simulation of reflectometry measurement applied to the experimental characterisation of Alfvén Cascades on the JET tokamak

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It was recently shown at JET [1] that O-mode fixed-frequency reflectometry measurement performed in the interferometry regime (i.e. using a probing frequency larger than the cut-off frequency maximum) allows a clear time-frequency determination of Alfvén Eigenmodes, in particular of Alfvén Cascades (ACs) that are hardly detected by external Mirnov coils. Such measurements are possible if the probing beam is launched perpendicularly to the inner wall and then reflected back to the receiving antenna. In order to estimate the phase perturbations of the reflected signal induced by density fluctuations associated with ACs, 1D and 2D WKB simulations have been carried out taking into account the real poloidal geometry of the JET reflectometer measurements. The density profile inferred from the JET Thomson Scattering LIDAR diagnostic and the radial envelope of the density fluctuations, deduced from both the MSE data and the MISHKA-H [2] and NOVA-K [3] codes, were used as inputs. The influence of the AC structure in the directions transverse to the probing beam (poloidal and toroidal) on the interpretation of these results are described. In the case of JET whose plasma diameter is large, it is found that 1D WKB approach is sufficient to accurately determine the phase fluctuations induced by ACs with poloidal mode numbers up to $m \cong 32$. For ACs occurring at the rational magnetic surface $q=2$ for instance, this corresponds to toroidal mode numbers up to $n \cong 16$. For ACs with higher poloidal and toroidal mode numbers, 2D computations are required to take into account the antenna radiation pattern, which cannot be ignored for short transverse fluctuation wavelengths. The effect of the radial structure of the ACs on the reflectometry measurements is also studied, indicating that ACs with even radial mode numbers ($l= 0, 2, \ldots$) are preferentially detected by this technique. Finally, we show that the level of density fluctuations associated with ACs can be obtained by matching the phase fluctuations deduced experimentally with those given by the WKB computations.

[1] S. E. Sharapov *et al*, Phys. Rev. Lett., **93**, 165001-1 (2004)

[2] S. E. Sharapov *et al*, Physics of Plasmas, **11**, 2286 (2004)

[3] C. Z. Cheng, Phys. Rep., **211**, 1 (1992)

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* See the Appendix of J.Pamela et al., Fusion Energy 2004 (Proc. 20th Int. Conf. Vilamoura, 2004) IAEA, Vienna (2004)